

How Are Animals & Airplanes Connected?



For thousands of years, people dreamed of flying like birds. Detailed sketches of flying machines were made about 500 years ago. Many of these machines featured mechanical wings that were intended to flap like the wings of a bird. But human muscles are not powerful enough to make such wings flap. Later, inventors studied birds such as eagles, which often glide through the air on outstretched wings. Successful gliders were built in the 1800s, but the gliders had no source of power to get them off the ground—and they were hard to control. Around 1900, two inventors studied bird flight more carefully and discovered that birds steer by changing the shape and position of their wings. The inventors built an engine-powered flying machine equipped with wires that could cause small changes in the shape and position of the wings. Though hardly as graceful as a soaring bird, the first powered, controlled flight took place in 1903, in the airplane seen here.



unit projects

Visit life.msscience.com/unit_project to find project ideas and resources.

Projects include:

- **History** Research Charles Darwin and his system for classifying animals. Write a time-travel interview to express your new knowledge.
- **Technology** Explore a biology-related career, and then write a want ad for a new job position.
- **Model** Study an animal, its characteristics, and habitat. Design a lunch bag with your new knowledge. A snack related to your animal may be placed inside to share with your classmates.



Investigate *Origins of Birds* to learn about the theory that birds descended from theropod dinosaurs. Compare and contrast bird

◀ **CONTENTS**


▶ **te** **tics** with other animals.

Glenn W. Ellison

Introduction to Animals

chapter preview

sections

- 1** Is it an animal?
 - 2** Sponges and Cnidarians
Lab Observing a Cnidarian
 - 3** Flatworms and Roundworms
Lab Comparing Free-living and Parasitic Flatworms
-  **Virtual Lab** How do sponges, cnidarians, flatworms, and roundworms obtain food?

Plant or Animal?



There are many animals on Earth, and not all look like a cat or a dog. A coral is an animal, and a coral reef is made of millions of these animals. By studying how animals are classified today, scientists can identify the relationships that exist among different animal groups.

Science Journal List all of the animals that you can identify in this picture.

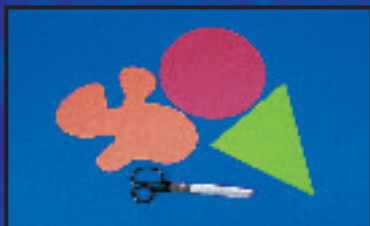
Start-Up Activities



Animal Symmetry

The words *left* and *right* have meaning to you because your body has a left and a right side. But what is left or right to a jellyfish or sea star? How an animal's body parts are arranged is called symmetry. In the following lab, you will compare three types of symmetry found in animals.  

1. On a piece of paper, draw three shapes—a circle, a triangle with two equal sides, and a free-form shape—then cut them out.
2. See how many different ways you can fold each shape through the center to make similar halves with each fold.
3. **Think Critically** Record which shapes can be folded into equal halves and which shapes cannot. Can any of the shapes be folded into equal halves more than one way? Which shape would be similar to a human? A sea star? A sponge?



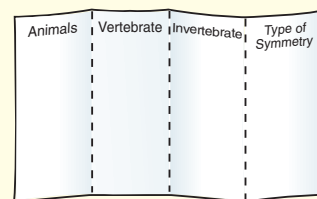
FOLDABLES™ Study Organizer

Animal Classification Make the following Foldable to help you classify the main characteristics of different animals.

- STEP 1** **Fold** a piece of paper in half from top to bottom and then fold it in half again to divide it into fourths.



- STEP 2** **Turn** the paper vertically, **unfold and label** the four columns as shown.



Read for Main Ideas As you read this chapter, list the characteristics of different animals in the appropriate column.



Preview this chapter's content and activities at life.msscience.com

Is it an animal?

as you read

What You'll Learn

- **Identify** the characteristics common to most animals.
- **Determine** how animals meet their needs.
- **Distinguish** between invertebrates and vertebrates.

Why It's Important

Animals provide food, medicines, and companionship in your daily life.



Review Vocabulary

adaptation: any variation that makes an organism better suited to its environment

New Vocabulary

- herbivore
- carnivore
- omnivore
- vertebrate
- invertebrate
- radial symmetry
- bilateral symmetry

Animal Characteristics

From microscopic worms to giant whales, the animal kingdom includes an amazing variety of living things, but all of them have certain characteristics in common. What makes the animals in **Figure 1** different from plants? Is it because animals eat other living things? Is this enough information to identify them as animals? What characteristics do animals have?

1. Animals are made of many cells. Different kinds of cells carry out different functions such as sensing the environment, getting rid of wastes, and reproducing.
2. Animal cells have a nucleus and specialized structures inside the cells called organelles.
3. Animals depend on other living things in the environment for food. Some eat plants, some eat other animals, and some eat plants and animals.
4. Animals digest their food. The proteins, carbohydrates, and fats in foods are broken down into simpler molecules that can move into the animal's cells.
5. Many animals move from place to place. They can escape from their enemies and find food, mates, and places to live. Animals that move slowly or not at all have adaptations that make it possible for them to take care of these needs in other ways.
6. All animals are capable of reproducing sexually. Some animals also can reproduce asexually.

Figure 1 These organisms look like plants, but they're one of the many plantlike animals that can be found growing on shipwrecks and other underwater surfaces.

Infer how these animals obtain food.



Figure 2 Animals eat a variety of foods.



Chitons eat algae from rocks.



A red-tailed hawk uses its sharp beak to tear the flesh.



Cardinal fish eat small invertebrates and some plant material.

How Animals Meet Their Needs

Any structure, process, or behavior that helps an organism survive in its environment is an adaptation. Adaptations are inherited from previous generations. In a changing environment, adaptations determine which individuals are more likely to survive and reproduce.

Adaptations for Obtaining Energy One of the most basic needs of animals is the need for food. All animals have adaptations that allow them to obtain, eat, and digest different foods. The chiton, shown in **Figure 2**, deer, some fish, and many insects are examples of herbivores. **Herbivores** eat only plants or parts of plants. In general, herbivores eat more often and in greater amounts than other animals because plants don't supply as much energy as other types of food.

 **Reading Check** *Why are butterflies considered to be herbivores?*

Animals that eat only other animals, like the red-tailed hawk in **Figure 2**, are **carnivores**. Most carnivores capture and kill other animals for food. But some carnivores, called scavengers, eat only the remains of other animals. Animal flesh supplies more energy than plants do, so carnivores don't need to eat as much or as often as herbivores.

Animals that eat plants and animals or animal flesh are called **omnivores**. Bears, raccoons, robins, humans, and the cardinal fish in **Figure 2** are examples of omnivores.

Many beetles and other animals such as millipedes feed on tiny bits of decaying matter called detritus (dih TRI tus). They are called detritivores (dih TRI tih vorz).



Carnivore Lore

Carnivores have always been written about as having great power and strength. Find a poem or short story about a carnivore and interpret what the author is trying to convey about the animal.

Figure 3 The pill bug's outer covering protects it and reduces moisture loss from its body.



Physical Adaptations Some prey species have physical features that enable them to avoid predators. Outer coverings protect some animals. Pill bugs, as seen in **Figure 3**, have protective plates. Porcupines have sharp quills that prevent most predators from eating them. Turtles and many animals that live in water have hard shells that protect them from predators.

Size is also a type of defense. Large animals are usually safer than small animals. Few predators will attack animals such as moose or bison simply because they are so large.

Mimicry is an adaptation in which one animal closely resembles another animal in appearance or behavior. If predators cannot distinguish between the two, they usually will not eat either animal. The venomous coral snake and the non-venomous scarlet king snake, shown in **Figure 4**, look alike. In some cases, this is a disadvantage for scarlet king snakes because people mistake them for coral snakes and kill them.



Reading Check

How might mimicry be an advantage and a disadvantage for an animal?

Many animals, like the flounder in **Figure 5**, blend into their surrounding environment, enabling them to hide from their predators. English peppered moths are brown and speckled like the lichens (LI kunz) on trees, making it difficult for their predators to see them. Many freshwater fish, like the trout also in **Figure 5**, have light bellies and dark, speckled backs that blend in with the gravelly bottoms of their habitats when they are viewed from above. Any marking or coloring that helps an animal hide from other animals is called camouflage. Some animals, like the cuttlefish in **Figure 5**, have the ability to change their color depending on their surroundings.

Modeling Animal Camouflage

Procedure

1. Pretend that a room in your home is the world of some fictitious animal. From **materials you can find around your home**, build a fictitious animal that would be camouflaged in this world.
2. Put your animal into its world and ask someone to find it.

Analysis

1. In how many places was your animal camouflaged?
2. What changes would increase its chances of surviving in its world?



Figure 4 Mimicry helps some animals survive.

Describe the difference between the two snakes.



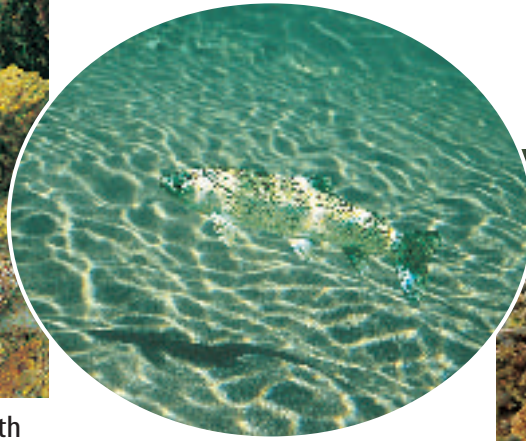
Coral snake



Scarlet king snake

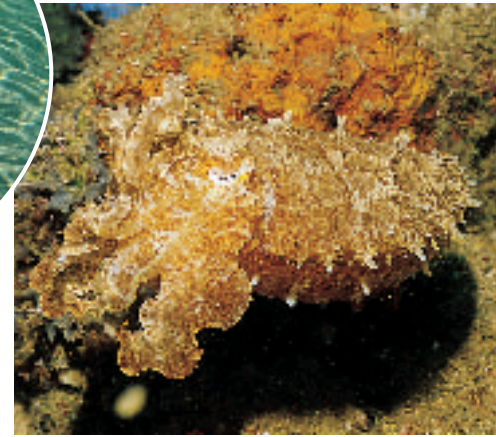


Bottom fish like this flounder, blend with the ocean floor.



A trout blends with the bottom of a stream.

Figure 5 Many types of animals blend with their surroundings.



Cuttlefish can be especially difficult to find because they can change color to blend with their surroundings.

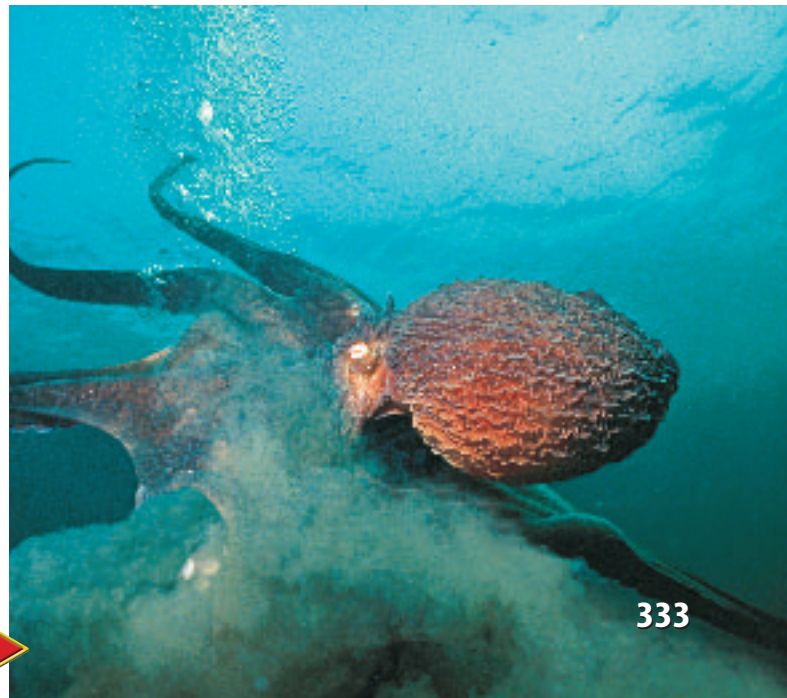
Predator Adaptations Camouflage is an adaptation for many predators so they can sneak up on their prey. Tigers have stripes that hide them in tall grasses. Killer whales are black on their upper surface and white underneath. When seen from above, the whale blends into the darkness of the deep ocean. The killer whale's white underside appears to be nearly the same color as the bright sky overhead when viewed from below. Adaptations such as these enable predators to hunt prey more successfully.

Behavioral Adaptations In addition to physical adaptations, animals have behavioral adaptations that enable them to capture prey or to avoid predators. Chemicals are used by some animals to escape predators. Skunks spray attacking animals with a bad-smelling liquid. Some ants and beetles also use this method of defense. When squid and octopuses are threatened, they release a cloud of ink so they can escape, as shown in **Figure 6**.

Some animals are able to run faster than most of their predators. The Thomson's gazelle can run at speeds up to 80 km/h. A lion can run only about 36 km/h, so speed is a factor in the Thomson's gazelle's survival.

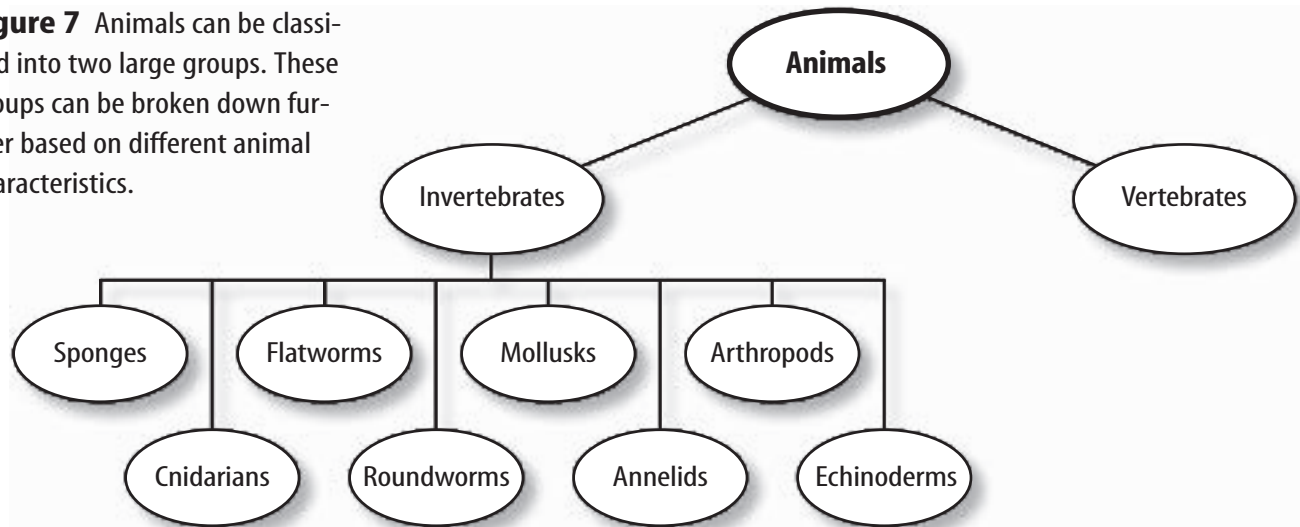
Traveling in groups is a behavior that is demonstrated by predators and prey. Herring swim in groups called schools that resemble an organism too large for a predator fish to attack. On the other hand, when wolves travel in packs, they can successfully hunt large prey that one predator alone could not capture.

Figure 6 An octopus's cloud of ink confuses a predator long enough for the octopus to escape.



(d) Tom J. Ulrich/Visuals Unlimited, (c) Peter & Beverly Pickford/DRK Photo, (tr) Fred McComaughy/Photo Researchers, (b) Stuart Westmoreland/Mo Yung Productions/Norbert Wu Productions

Figure 7 Animals can be classified into two large groups. These groups can be broken down further based on different animal characteristics.



Animal Classification

Scientists have identified and named more than 1.8 million species of animals. It is estimated that there are another 3 million to 30 million more to identify and name. Animals can be classified into two major groups, as shown in **Figure 7**. All animals have common characteristics, but those in one group have more, similar characteristics because all the members of a group probably descended from a common ancestor. When a scientist finds a new animal, how does he or she begin to classify it?

Check for a Backbone To classify an animal, a scientist first looks to see whether or not the animal has a backbone. Animals with backbones are called **vertebrates**. Their backbones are made up of a stack of structures called vertebrae that support the animal. The backbone also protects and covers the spinal cord—a bundle of nerves that is connected to the brain. The spinal cord carries messages to all other parts of the body. It also carries messages from other parts of the body to the brain. Examples of vertebrates include fish, frogs, snakes, birds, and humans.

An animal without a backbone is classified as an **invertebrate**. About 97 percent of all animal species are invertebrates. Sponges, jellyfish, worms, insects, and clams are examples of invertebrates. Many invertebrates are well protected by their outer coverings. Some have shells, some have a skeleton on the outside of their body, and others have a spiny outer covering.

Symmetry After determining whether or not a backbone is present, a scientist might look at an animal's symmetry (SIH muh tree). Symmetry is how the body parts of an animal are arranged. Organisms that have no definite shape are called asymmetrical. Most sponges are asymmetrical animals.



Topic: Animal Classification

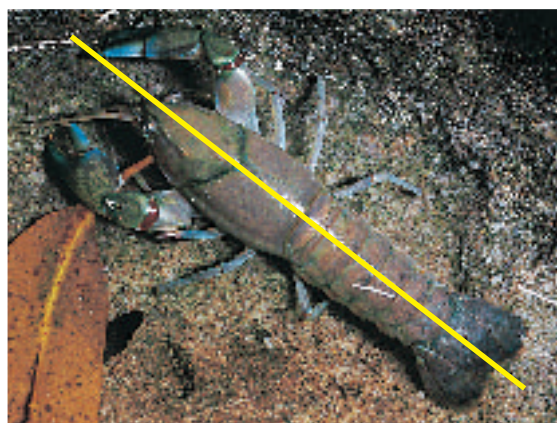
Visit life.msscience.com for Web links to information about how the classification of an animal can change as new information is learned.

Activity Name a recent reclassification of an animal and one reason it was reclassified.



Figure 8 Symmetry is a characteristic of all animals.

Sea urchins can sense things from all directions.



Animals that have body parts arranged in a circle around a center point, the way spokes of a bicycle wheel are arranged, have **radial symmetry**. Hydras, jellyfish, sea urchins, like the one in **Figure 8**, and some sponges have radial symmetry.

Most animals have bilateral symmetry. In Latin, the word *bilateral* means “two sides.” An animal with **bilateral symmetry**, like the crayfish shown in **Figure 8**, can be divided into right and left halves that are nearly mirror images of each other.

After an animal is classified as an invertebrate or a vertebrate and its symmetry is determined, other characteristics are identified that place it in one of the groups of animals with which it has the most characteristics in common. Sometimes a newly discovered animal is different from any existing group, and a new classification group is formed for that animal.

Most animals have bilateral symmetry like this crayfish. **Name** the type of symmetry you have.

section

1

review

Summary

Animal Characteristics

- Animals are made of many eukaryotic cells.
- Animals obtain and digest food, reproduce and most move from place to place.

How Animals Meet Their Needs

- Animals have many different physical, predatory, and behavioral adaptations.
- Animals can be herbivores, carnivores, omnivores, or detritivores depending on what they eat.

Animal Classification

- Scientists classify animals in two large groups: vertebrates and invertebrates.
- An animal's symmetry plays a role in its classification.

Self Check

1. **Explain** different adaptations for obtaining food.
2. **Compare and contrast** invertebrates and vertebrates.
3. **List** the three types of symmetry. Give an example for each type.
4. **Think Critically** Radial symmetry is found among species that live in water. Why might radial symmetry be an uncommon adaptation of animals that live on land?

Applying Skills

5. **Concept Map** Make an events-chain concept map showing the steps used to classify a new animal.
6. **Communicate** Choose an animal you are familiar with. Describe the adaptations it has for getting food and avoiding predators.

Sponges and Cnidarians

as you read

What You'll Learn

- **Describe** the characteristics of sponges and cnidarians.
- **Explain** how sponges and cnidarians obtain food and oxygen.
- **Determine** the importance of living coral reefs.

Why It's Important

Sponges and cnidarians are important to medical research because they are sources of chemicals that fight disease.



Review Vocabulary

flagella: long, thin whiplike structures that grow from a cell

New Vocabulary

- sessile
- hermaphrodite
- polyp
- medusa
- tentacle
- stinging cell

Sponges

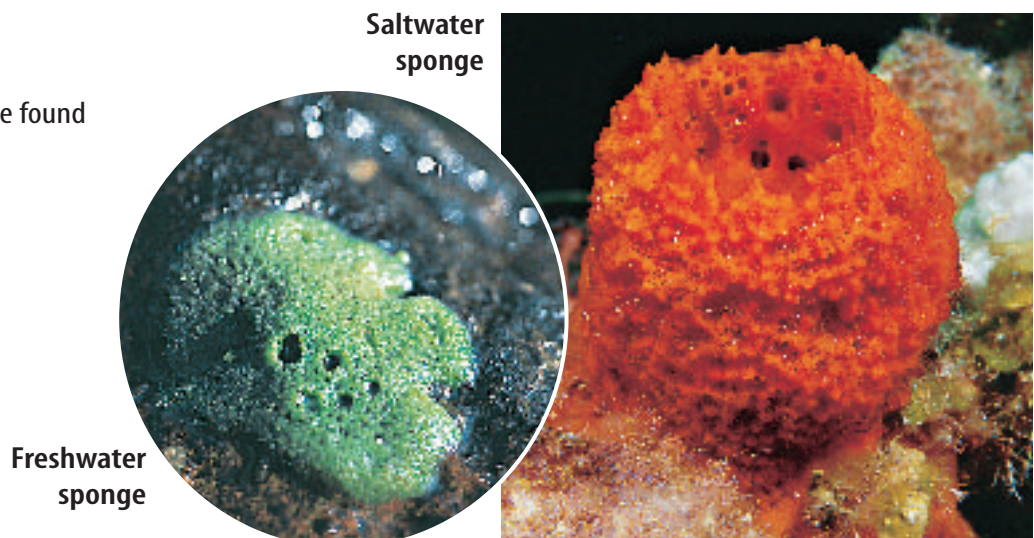
In their watery environments, sponges play many roles. They interact with many other animals such as worms, shrimp, snails, and sea stars. These animals live on, in, and under sponges. Sponges also are important as a food source for some snails, sea stars, and fish. Certain sponges contain photosynthetic bacteria and protists that provide oxygen and remove wastes for the sponge.

Only about 17 species of sponges are commercially important. Humans have long used the dried and cleaned bodies of some sponges for bathing and cleaning. Most sponges you see today are synthetic sponges or vegetable loofah sponges, but natural sea sponges like those in **Figure 9** still are available.

Today scientists are finding other uses for sponges. Chemicals made by sponges are being tested and used to make drugs that fight disease-causing bacteria, fungi, and viruses. These chemicals also might be used to treat certain forms of arthritis.

Origin of Sponges Fossil evidence shows that sponges appeared on Earth about 600 million years ago. Because sponges have little in common with other animals, many scientists have concluded that sponges probably evolved separately from all other animals. Sponges living today have many of the same characteristics as their fossilized ancestors.

Figure 9 Sponges can be found in a variety of habitats.



Saltwater sponge

Freshwater sponge

Characteristics of Sponges

Most of the 5,000 species of sponges are found in warm, shallow salt water near coastlines, although some are found at ocean depths of 8,500 m or more. A few species, like the one in **Figure 9**, live in freshwater rivers, lakes, and streams. The colors, shapes, and sizes of sponges vary. Saltwater sponges are brilliant red, orange, yellow, or blue, while freshwater sponges are usually a dull brown or green. Some sponges have radial symmetry, but most are asymmetrical. Sponges can be smaller than a marble or larger than a compact car.

Adult sponges live attached to one place unless they are washed away by strong waves or currents. Organisms that remain attached to one place during their lifetimes are called **sessile** (SE sile). They often are found with other sponges in permanent groups called colonies. Early scientists classified sponges as plants because they didn't move. As microscopes were improved, scientists observed that sponges couldn't make their own food, so sponges were reclassified as animals.

Body Structure A sponge's body, like the one in **Figure 10**, is a hollow tube that is closed at the bottom and open at the top. The sponge has many small openings in its body. These openings are called pores.

Sponges have less complex body organization than other groups of animals. They have no tissues, organs, or organ systems. The body wall has two cell layers made up of several different types of cells. Those that line the inside of the sponge are called collar cells. The beating motion of the collar cells' flagella moves water through the sponge.

Many sponge bodies contain sharp, pointed structures called spicules (SPIH kyewlz). The soft-bodied, natural sponges that some people use for bathing or washing their cars have skeletons of a fibrous material called spongin. Other sponges contain spicules and spongin. Spicules and spongin provide support for a sponge and protection from predators.

Figure 10 Specialized cells, called collar cells, have flagella that move water through the pores in a sponge. Other cells filter microscopic food from the water as it passes through.

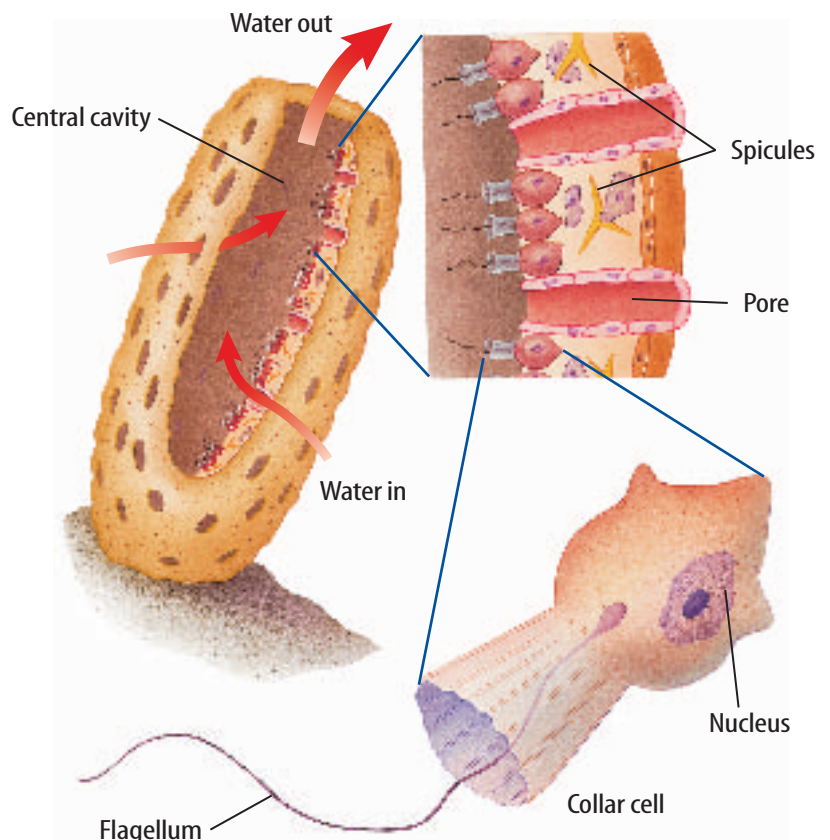
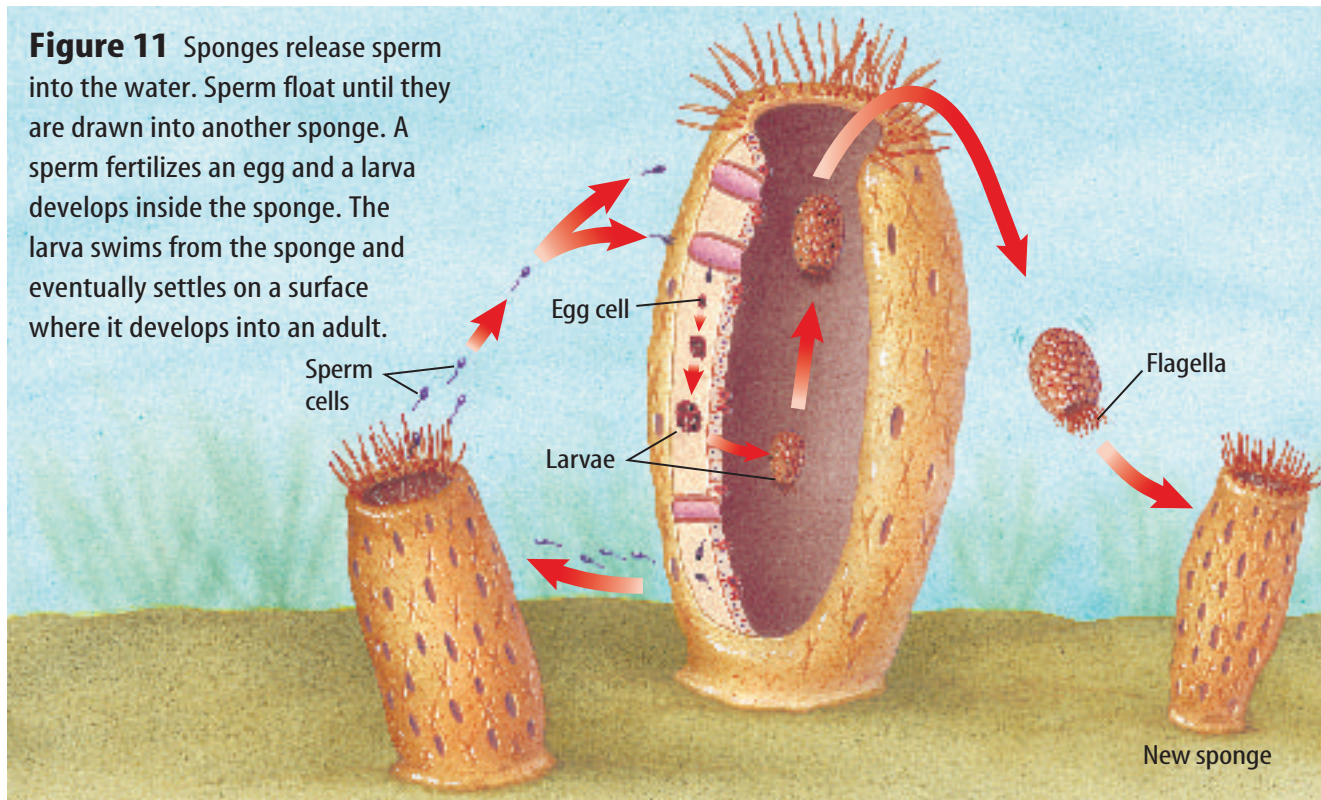


Figure 11 Sponges release sperm into the water. Sperm float until they are drawn into another sponge. A sperm fertilizes an egg and a larva develops inside the sponge. The larva swims from the sponge and eventually settles on a surface where it develops into an adult.



Obtaining Food and Oxygen Sponges filter microscopic food particles such as bacteria, algae, protists, and other materials from the water as it is pulled in through their pores. Oxygen also is removed from the water. The filtered water carries away wastes through an opening in the top of the sponge.

 **Reading Check** How do sponges get oxygen?

Reproduction Sponges can reproduce sexually, as shown in **Figure 11**. Some species of sponges have separate sexes, but most sponge species are **hermaphrodites** (hur MA fruh dites)—animals that produce sperm and eggs in the same body. However, a sponge's sperm cannot fertilize its own eggs. After an egg is released, it might be fertilized and then develop into a larva (plural, *larvae*). The larva usually looks different from the adult form. Sponge larvae have cilia that allow them to swim. After a short time, the larvae settle down on objects where they will remain and grow into adult sponges.

Asexual reproduction occurs by budding or regeneration. A bud forms on a sponge, then drops from the parent sponge to grow on its own. New sponges also can grow by regeneration from small pieces of a sponge. Regeneration occurs when an organism grows new body parts to replace lost or damaged ones. Sponge growers cut sponges into pieces, attach weights to them, and put them back into the ocean to regenerate.



INTEGRATE Chemistry

Spicule Composition

Spicules of glass sponges are composed of silica. Other sponges have spicules of calcium carbonate. Relate the composition of spicules to the composition of the water in which the sponge lives. Write your answer in your Science Journal.

Cnidarians

Another group of invertebrates includes colorful corals, flowerlike sea anemones, tiny hydras, delicate jellyfish, and the iridescent Portuguese man-of-war, shown in **Figure 12**. These animals are classified as cnidarians (ni DAR ee uhnz).

Cnidarian Environments Most cnidarians live in salt water, although many types of hydras live in freshwater. Sea anemones and most jellyfish, also called jellies, live as individual organisms. Hydras and corals tend to form colonies.

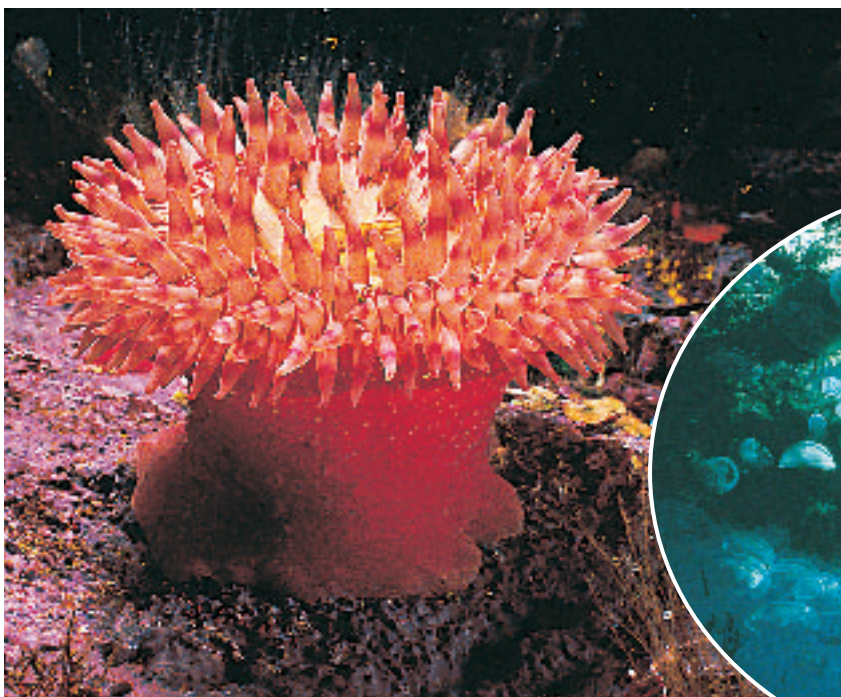
Two Body Forms Cnidarians have two different body forms. The **polyp** (PAH lup) form, shown in **Figure 13** on the left, is shaped like a vase and usually is sessile. Sea anemones, corals, and hydras are cnidarians that live most of their lives as polyps. The **medusa** (mih DEW suh) form, shown in **Figure 13** on the right, is bell-shaped and free-swimming. A jelly spends most of its life as a medusa floating on ocean currents. Some species of jellies have tentacles that grow to 30 m and trail behind the animal.



Reading Check

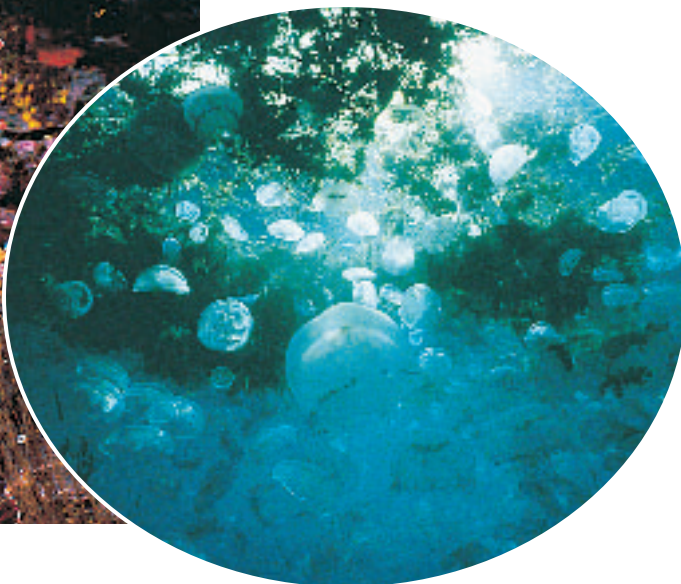
What are some possible benefits of having a medusa and a polyp form?

Figure 12 The Portuguese man-of-war also is called the bluebottle. This animal is not one organism. It is four kinds of cnidarians that depend on one another for survival.



Adult sea anemones are polyps that grow attached to the ocean bottom, a rock, coral, or any surface. They depend on the movement of water to bring them food.

Figure 13 Cnidarians have medusa and polyp body forms.



Jellies can perform upward movements but must float to move downward.

Body Structure All cnidarians have one body opening and radial symmetry. They have more complex bodies than sponges do. They have two cell layers that are arranged into tissues and a digestive cavity where food is broken down. In the two-cell-layer body plan of cnidarians, no cell is ever far from the water. In each cell, oxygen from the water is exchanged for carbon dioxide and other cell wastes.

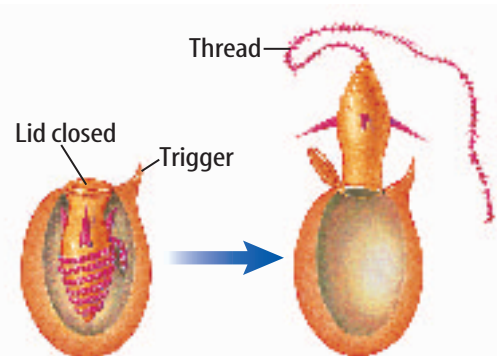
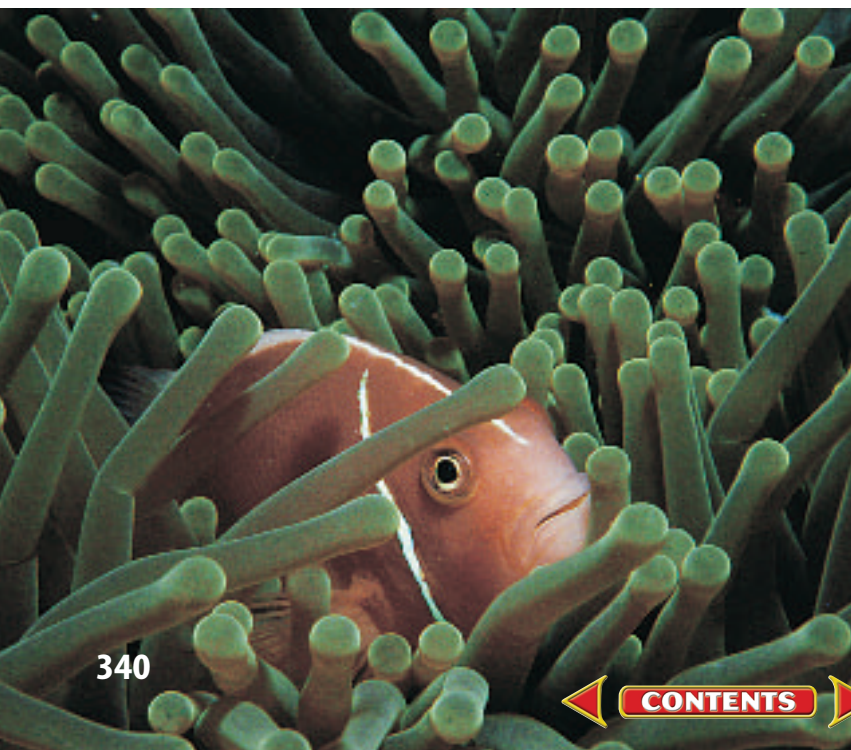
Cnidarians have a system of nerve cells called a nerve net. The nerve net carries impulses and connects all parts of the organism. This makes cnidarians capable of some simple responses and movements. Hydras can somersault away from a threatening situation.

Armlike structures called **tentacles** (TEN tih kulz) surround the mouths of most cnidarians. Certain fish, shrimp, and other small animals live unharmed among the tentacles of large sea anemones, as shown in **Figure 14A**. The tentacles have stinging cells. A **stinging cell**, as shown in **Figure 14B**, has a capsule with a coiled, threadlike structure that helps the cnidarian capture food. Animals that live among an anemone's tentacles are not affected by the stinging cells. The animals are thought to help clean the sea anemone and protect it from certain predators.

Figure 14 Tentacles surround the mouth of a sea anemone.

A Clown fish are protected from the sea anemone's sting by a special mucous covering. The anemone eats scraps that the fish drop, and the fish are protected from predators by the anemone's sting.

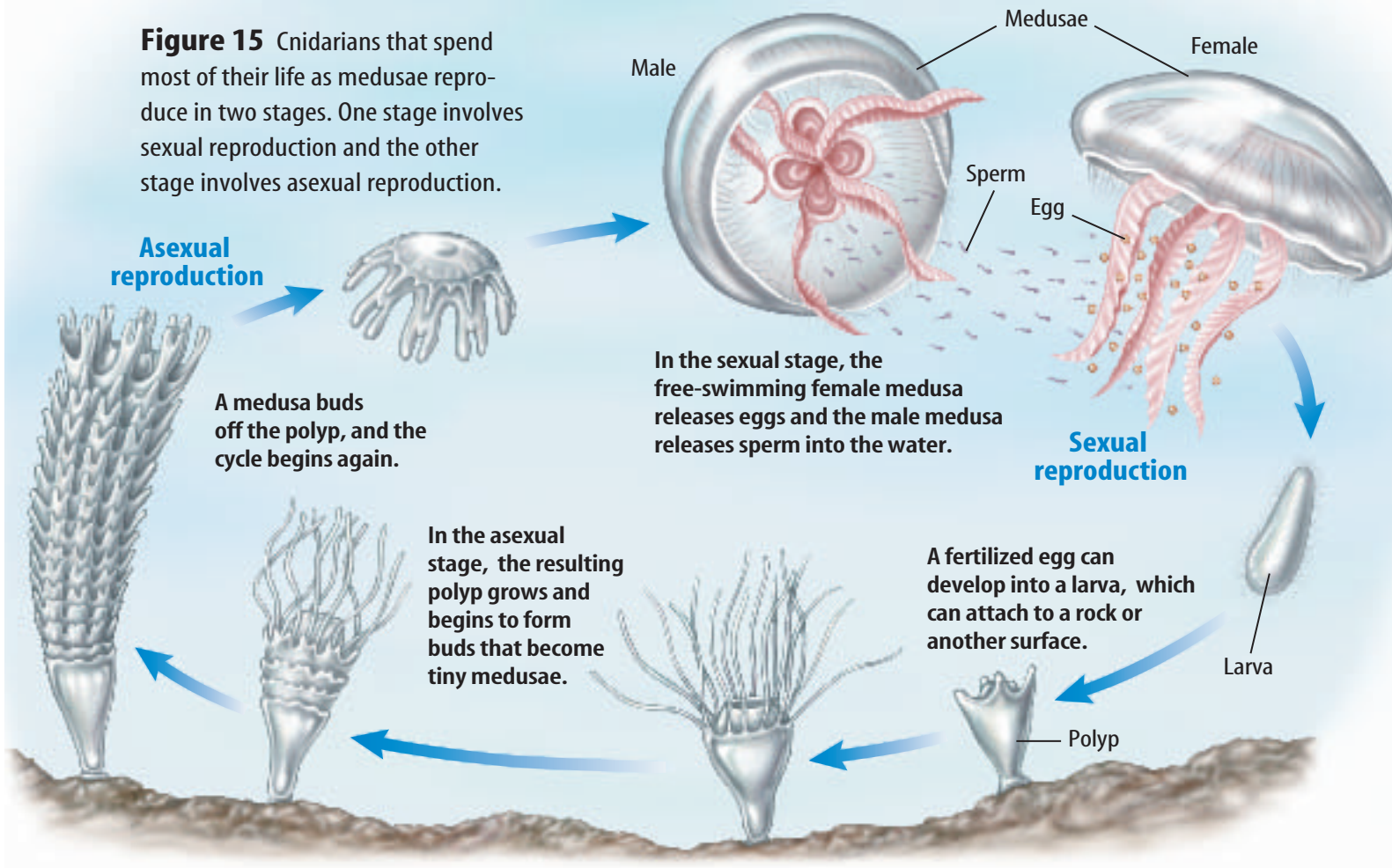
Obtaining Food Cnidarians are predators. Some can stun their prey with nerve toxins produced by stinging cells. The threadlike structure in the stinging cell is sticky or barbed. When a cnidarian is touched or senses certain chemicals in its environment, the threadlike structures discharge and capture the prey. The tentacles bring the prey to the mouth, and the cnidarian ingests the food. Because cnidarians have only one body opening, undigested food goes back out through the mouth.



B A sea anemone's stinging cells have triggerlike structures. When prey brushes against the trigger, the thread is released into the prey. A toxin in the stinging cell stuns the prey.

Identify the type of adaptation this is: physical, behavior, or predatory. Explain your answer.

Figure 15 Cnidarians that spend most of their life as medusae reproduce in two stages. One stage involves sexual reproduction and the other stage involves asexual reproduction.



Reproduction Cnidarians reproduce asexually and sexually, as shown in **Figure 15**. Polyp forms reproduce asexually by producing buds that eventually fall off the cnidarian and develop into new polyps. Polyps also reproduce sexually by producing eggs or sperm. Sperm are released into the water and fertilize the eggs, which also are released into the water.

Medusa (plural, *medusae*) forms of cnidarians have two stages of reproduction—a sexual stage and an asexual stage. Free-swimming medusae produce eggs or sperm and release them into the water. The eggs are fertilized by sperm from another medusa of the same species and develop into larvae. The larvae eventually settle down and grow into polyps. When young medusae bud off the polyp, the cycle begins again.

Origin of Cnidarians

The first cnidarians might have been on Earth more than 600 million years ago. Scientists hypothesize that the medusa body was the first form of cnidarian. Polyps could have formed from larvae of medusae that became permanently attached to a surface. Most of the cnidarian fossils are corals.



Figure 16 Coral reefs are colonies made up of many individual corals.

Infer the benefit of living in a colony for the corals.

Corals



The large coral reef formations found in shallow tropical seas are built as one generation of corals secretes their hard external skeletons on those of earlier generations. It takes millions of years for large reefs, such as those found in the waters of the Indian Ocean, the south Pacific Ocean, and the Caribbean Sea, to form.

Importance of Corals Coral reefs, shown in **Figure 16**, are productive ecosystems and extremely important in the ecology of tropical waters. They have a diversity of life comparable to tropical rain forests. Some of the most beautiful and fascinating animals of the world live in the formations of coral reefs.

Beaches and shorelines are protected from much of the action of waves by coral reefs. When coral reefs are destroyed or severely damaged, large amounts of shoreline can be washed away.

If you go scuba diving or snorkeling, you might explore a coral reef. Coral reefs are home for organisms that provide valuable shells and pearls. Fossil reefs can give geologists clues about the location of oil deposits.

Like sponges, corals produce chemicals to protect themselves from diseases or to prevent other organisms from settling on them. Medical researchers are learning that some of these chemicals might provide humans with drugs to fight cancer. Some coral is even used as a permanent replacement for missing sections of bone in humans.

section 2 review

Summary

Sponges

- Most sponges live in salt water, are sessile, and vary in size, color, and shape.
- A sponge has no tissues, organs, or organ systems.
- Sponges filter food from the water, and reproduce sexually and asexually.

Cnidarians

- Cnidarians live mostly in salt water and have two body forms: polyp and medusa.
- Cnidarians have nerve cells, tissues, and a digestive cavity.
- Corals are cnidarians that make up a diverse ecosystem called a coral reef.

Self Check

1. **Compare and contrast** how sponges and cnidarians get their food.
2. **Describe** the two body forms of cnidarians and tell how each reproduces.
3. **Infer** why most fossils of cnidarians are coral fossils. Would you expect to find a fossil sponge? Explain.
4. **Think Critically** What effect might the destruction of a large coral reef have on other ocean life?

Applying Math

5. **Solve One-Step Equations** A sponge 1 cm in diameter and 10 cm tall can move 22.5 L of water through its body each day. What volume of water will it pump through its body in 1 h? In 1 min?

Observing a Cnidarian

The hydra has a body cavity that is a simple, hollow sac. It is one of the few freshwater cnidarians.

Real-World Question

How does a hydra react to food and other stimuli?

Goals

- **Predict** how a hydra will respond to various stimuli.
- **Observe** how a hydra responds to stimuli.

Materials

dropper toothpick
hydra culture *Daphnia* or brine shrimp
small dish stereomicroscope

Safety Precautions



Procedure

1. Copy the data table and use it to record your observations.

Hydra Observations	
Features	Observations
Color	Do not write in this book.
Number of tentacles	
Reaction to touch	
Reaction to food	

2. Use a dropper to place a hydra and some of the water in which it is living into a dish.
3. Place the dish on the stage of a stereomicroscope. Bring the hydra into focus. Record the hydra's color.
4. **Identify** and count the number of tentacles. Locate the mouth.



5. Study the basal disk by which the hydra attaches itself to a surface.
6. **Predict** what will happen if the hydra is touched with a toothpick. Carefully touch the tentacles with a toothpick. Describe the reaction in the data table.
7. Drop a *Daphnia* or a small amount of brine shrimp into the dish. Observe how the hydra takes in food. Record your observations.
8. Return the hydra to the culture.

Conclude and Apply

1. **Analyze** what happened when the hydra was touched. What happened to other areas of the animal?
2. **Describe** the advantages tentacles provide for hydra.

Communicating Your Data

Compare your results with those of other students. Discuss whether all of the hydras studied had the same responses, and how the responses aid hydras in survival.

Flatworms and Roundworms

as you read

What You'll Learn

- **List** the characteristics of flatworms and roundworms.
- **Distinguish** between free-living and parasitic organisms.
- **Identify** disease-causing flatworms and roundworms.

Why It's Important

Many species of flatworms and roundworms cause disease in plants and animals.



Review Vocabulary

cilia: short, threadlike structures that aid in locomotion

New Vocabulary

- free-living organism
- anus

What is a worm?

Worms are invertebrates with soft bodies and bilateral symmetry. They have three tissue layers, as shown in **Figure 17**, which are organized into organs and organ systems.

Flatworms

As their name implies, flatworms have flattened bodies. Members of this group include planarians, flukes, and tapeworms. Some flatworms are free-living, but most are parasites, which means that they depend on another organism for food and a place to live. Unlike a parasite, a **free-living organism** doesn't depend on another organism for food or a place to live.

Planarians An example of a free-living flatworm is the planarian, as shown in **Figure 18**. It has a triangle-shaped head with two eyespots. Its one body opening—a mouth—is on the underside of the body. A muscular tube called the pharynx connects the mouth and the digestive tract. A planarian feeds on small organisms and dead bodies of larger organisms. Most planarians live under rocks, on plant material, or in freshwater. They vary in length from 3 mm to 30 cm. Their bodies are covered with fine, hairlike structures called cilia. As the cilia move, the worm is moved along in a slimy mucous track that is secreted from the underside of the planarian.

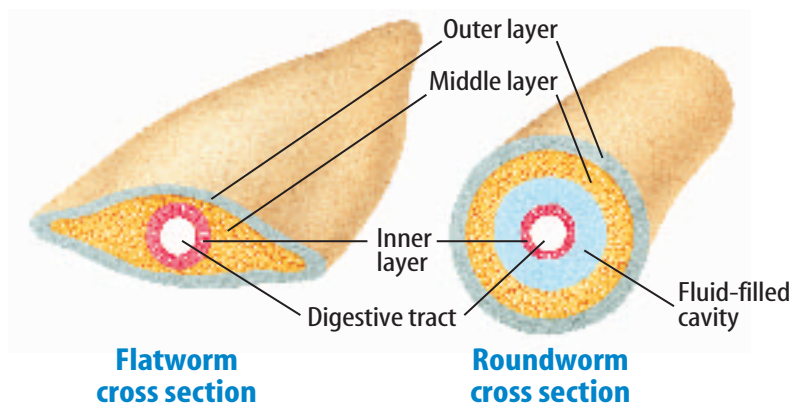
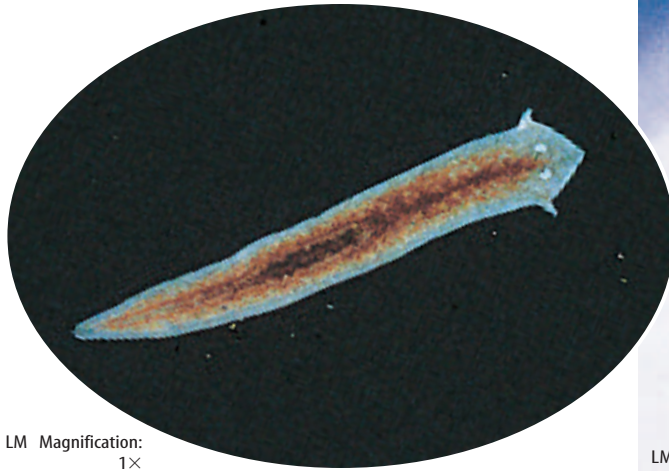


Figure 17 Worms have cells that are arranged into three specialized tissue layers and organs.

Figure 18 The planarian is a common freshwater flatworm.



LM Magnification:
1×

The planarian's eyespots sense light.



LM Magnification: 1×

Planarians can reproduce asexually by splitting, then regenerating the other half.

Planarians reproduce asexually by dividing in two, as shown in **Figure 18**. A planarian can be cut in two, and each piece will grow into a new worm. They also have the ability to regenerate. Planarians reproduce sexually by producing eggs and sperm. Most are hermaphrodites and exchange sperm with one another. They lay fertilized eggs that hatch in a few weeks.

Flukes All flukes are parasites with complex life cycles that require more than one host. Most flukes reproduce sexually. The male worm deposits sperm in the female worm. She lays the fertilized eggs inside the host. The eggs leave the host in its urine or feces. If the eggs end up in water, they usually infect snails. After they leave the snail, the young worms can burrow into the skin of a new host, such as a human, while he or she is standing or swimming in the water.

Of the many diseases caused by flukes, the most widespread one affecting humans is schistosomiasis (shis tuh soh MI uh sus). It is caused by blood flukes—flatworms that live in the blood, as shown in **Figure 19**. More than 200 million people, mostly in developing countries, are infected with blood flukes. It is estimated that 1 million people die each year because of them. Other types of flukes can infect the lungs, liver, eyes, and other organs of their host.

Figure 19 Female blood flukes deposit their eggs in the blood of their host. The eggs travel through the host and eventually end up in the host's digestive system.



Stained LM Magnification: 20×

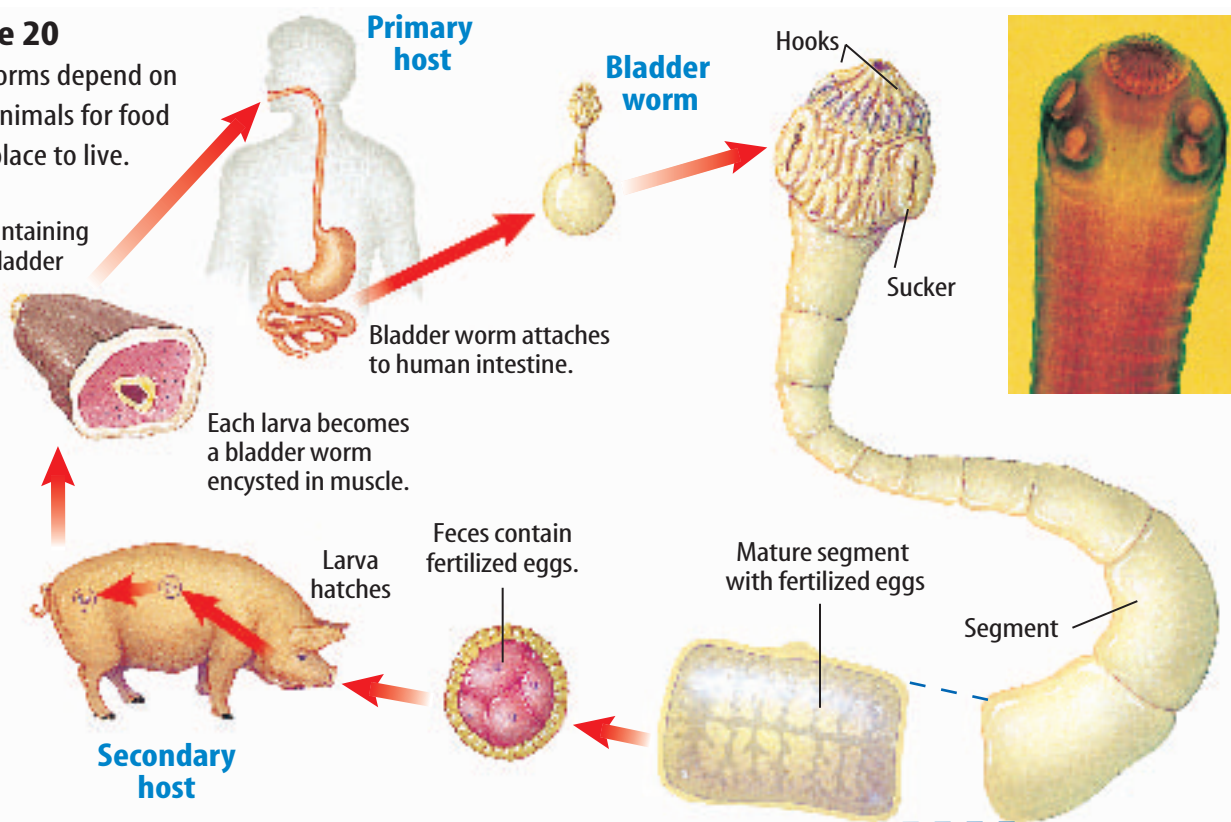


What is the most common disease that is caused by flukes?

Figure 20

Tapeworms depend on other animals for food and a place to live.

Meat containing many bladder worms



Tapeworms Another type of flatworm is the tapeworm. These worms are parasites. The adult form uses hooks and suckers to attach itself to the intestine of a host organism, as illustrated in **Figure 20**. Dogs, cats, humans, and other animals are hosts for tapeworms. A tapeworm doesn't have a mouth or a digestive system. Instead, the tapeworm absorbs food that is digested by the host from its host's intestine.

A tapeworm grows by producing new body segments immediately behind its head. Its ribbonlike body can grow to be 12 m long. Each body segment has both male and female reproductive organs. The eggs are fertilized by sperm in the same segment. After a segment is filled with fertilized eggs, it breaks off and passes out of the host's body with the host's wastes. If another host eats a fertilized egg, the egg hatches and develops into an immature tapeworm called a bladder worm.

Origin of Flatworms

Because of the limited fossil evidence, the evolution of flatworms is uncertain. Evidence suggests that they were the first group of animals to evolve bilateral symmetry with senses and nerves in the head region. They also were probably the first group of animals to have a third tissue layer that develops into organs and systems. Some scientists hypothesize that flatworms and cnidarians might have had a common ancestor.

Mini LAB

Observing Planarian Movement

Procedure

1. Use a **dropper** to transfer a **planarian** to a **watch glass**.
2. Add enough **water** so the planarian can move freely.
3. Place the glass under a **stereomicroscope** and observe the planarian.

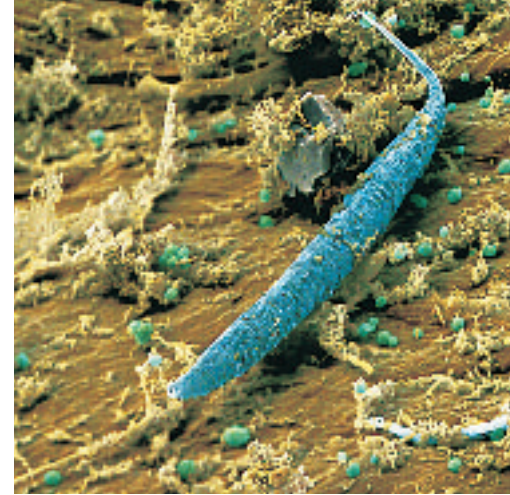
Analysis

1. Describe how a planarian moves in the water.
2. What body parts appear to be used in movement?
3. Explain why a planarian is a free-living flatworm.

Roundworms

If you own a dog, you've probably had to get medicine from your veterinarian to protect it from heartworms—a type of roundworm. Roundworms also are called nematodes and more nematodes live on Earth than any other type of many-celled organism. It is estimated that more than a half million species of roundworms exist. They are found in soil, animals, plants, freshwater, and salt water. Some are parasitic, but most are free-living.

Roundworms are slender and tapered at both ends like the one in **Figure 21**. The body is a tube within a tube, with fluid in between. Most nematode species have male and female worms and reproduce sexually. Nematodes have two body openings, a mouth, and an anus. The **anus** is an opening at the end of the digestive tract through which wastes leave the body.



Color-enhanced SEM Magnification: 1000×

Figure 21 Some roundworms infect humans and other animals. Others infect plants, and some are free-living in the soil.



What characteristics of roundworms might contribute to the success of the group?

Applying Math Use Percentages

SPECIES COUNTS In a forest ecosystem, about four percent of the 400 different animal species are roundworm species. How many roundworm species are in this ecosystem?

Solution

- 1** *This is what you know:*
 - total animal species = 400
 - roundworms species = 4% of total animal species
- 2** *This is what you must find out:* How many roundworm species are in the ecosystem?
- 3** *This is the procedure you need to use:*
 - Change 4% to a decimal. $\frac{4}{100} = 0.04$
 - Use following equation:
(roundworm-species percent as a decimal) \times (total animal species) = number of roundworm species
 - Substitute in known values:
 $0.04 \times 400 = 16$ roundworm species
- 4** *Check your answer:* Divide 16 by 0.04 and you should get 400.

Practice Problems

1. Flatworms make up 1.5 percent of all animal species in the forest ecosystem. How many flatworms species probably are present?
2. If there are 16 bird species present, what percent of the animal species are the bird species?

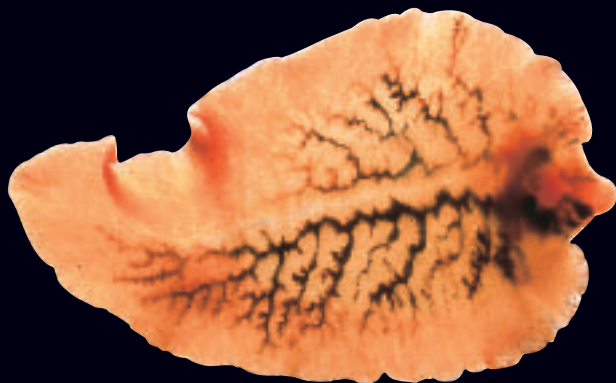
Scienceonline

For more practice, visit
[life.msscience.com/
math_practice](http://life.msscience.com/math_practice)



Figure 22

Many diseases are caused by parasitic roundworms and flatworms that take up residence in the human body. Some of these diseases result in diarrhea, weight loss, and fatigue; others, if left untreated, can be fatal. Micrographs of several species of roundworms and flatworms and their magnifications are shown here.



▲ **6×** **LIVER FLUKE** Humans and other mammals ingest the larvae of these parasites by eating contaminated plant material. Immature flukes penetrate the intestinal wall and pass via the liver into the bile ducts. There they mature into adults that feed on blood and tissue.

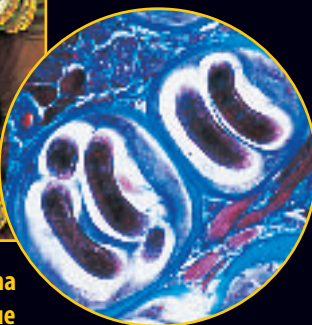
▶ **78×** **BLOOD FLUKE** These parasites live as larvae in lakes and rivers and penetrate the skin of people wading in the water. After maturing in the liver, the flukes settle in veins in the intestine and bladder, causing schistosomiasis (shis tuh soh MI uh sus), which damages the liver and spleen.



▼ **125×** **PINWORMS** Typically inhabiting the large intestine, the female pinworm lays her eggs near the host's anus, causing discomfort. The micrograph below shows pinworm eggs on a piece of clear tape.



▶ **200×** **Trichina larvae in muscle tissue**



◀ **170×** **ROUNDWORMS** The roundworms that cause the disease trichinosis (tri kuh NOH sus) are eaten as larvae in undercooked infected meat. They mature in the intestine, then migrate to muscle tissue, where they form painful cysts.



**Hookworm head
25×**

▶ **4×** **HOOKWORM** These parasites enter their human hosts as larvae by penetrating the skin of bare feet. From there, they migrate to the lungs and eventually to the intestine, where they mature.



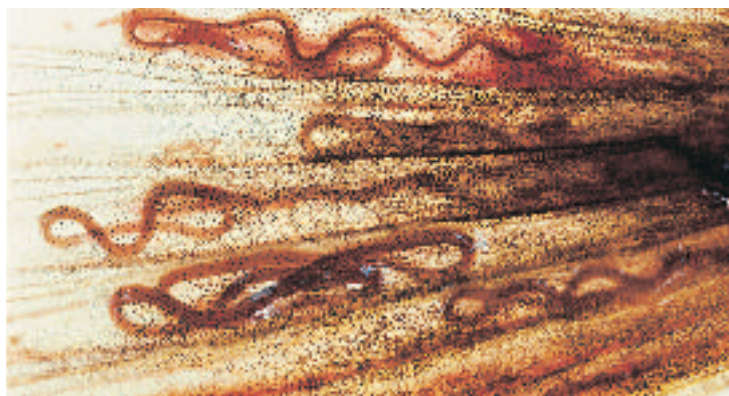
Origin of Roundworms More than 550 million years ago, roundworms appeared early in animal evolution. They were the first group of animals to have a digestive system with a mouth and an anus. Scientists hypothesize that roundworms are more closely related to arthropods than to vertebrates. However, it is still unclear how roundworms fit into the evolution of animals.

Importance of Roundworms Some roundworms, shown in **Figure 22**, cause diseases in humans. Others are parasites of plants or of other animals, such as the fish shown in **Figure 23**. Some nematodes cause damage to fiber, agricultural products, and food. It is estimated that the worldwide annual amount of nematode damage is in the millions of dollars.

Not all roundworms are a problem for humans, however. In fact, many species are beneficial. Some species of roundworms feed on termites, fleas, ants, beetles, and many other types of insects that cause damage to crops and human property. Some species of beneficial nematodes kill other pests. Research is being done with nematodes that kill deer ticks that cause Lyme disease.

Roundworms also are important because they are essential to the health of soil. They provide nutrients to the soil as they break down organic material. They also help in cycling nutrients such as nitrogen.

Figure 23 This fish's fin is infected with parasitic roundworms. These roundworms damage the fin, which makes it difficult for the fish to swim and escape from predators.



section 3 review

Summary

Common Characteristics

- Both flatworms and roundworms are invertebrates with soft bodies, bilateral symmetry, and three tissue layers that are organized into organs and organ systems.

Flatworms

- Flatworms have flattened bodies, and can be free-living or parasitic. They generally have one body opening.

Roundworms

- Also called nematodes, roundworms have a tube within a tube body plan. They have two openings: a mouth and an anus.

Self Check

- Compare and contrast** the body plan of a flatworm to the body plan of a roundworm.
- Distinguish** between a free-living flatworm and a parasitic flatworm.
- Explain** how tapeworms get energy.
- Identify** three roundworms that cause diseases in humans. How can humans prevent infection from each?
- Think Critically** Why is a flatworm considered to be more complex than a hydra?

Applying Skills

- Concept Map** Make an events-chain concept map for tapeworm reproduction.

Comparing Free-Living and Parasitic Flatworms

(t)T.E. Adams/Visuals Unlimited, (b)Bob Daemrich

Goals

- **Compare and contrast** the body parts and functions of free-living and parasitic flatworms.
- **Observe** how flatworms are adapted to their environments.

Possible Materials

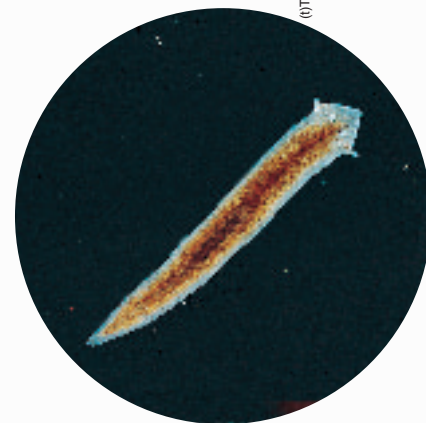
petri dish with a planarian
compound microscope
prepared slide of a tapeworm
stereomicroscope
light source, such as a lamp
small paintbrush
small piece of liver
dropper
water

Safety Precautions



Real-World Question

How are the body parts of flatworms adapted to the environment in which they live? Are the adaptations of free-living flatworms and parasitic flatworms the same?



Form a Hypothesis

Form a hypothesis about what adaptations you think free-living and parasitic worms might have. What would be the benefits of these adaptations?



▶ Test Your Hypothesis

Make a Plan

1. As a group, make a list of possible ways you might design a procedure to compare and contrast types of flatworms. Your teacher will provide you with information on handling live flatworms.
2. Choose one of the methods you described in step 1. List the steps you will need to take to follow the procedure. Be sure to describe exactly what you will do at each step of the activity.
3. **List** the materials that you will need to complete your experiment.
4. If you need a data table, design one in your Science Journal so it is ready to use when your group begins to collect data.

Follow Your Plan

1. Make sure your teacher approves your plan before you start.
2. Carry out the experiment according to the approved plan.
3. While the experiment is going on, record any observations that you make and complete the data table in your Science Journal.

▶ Analyze Your Data

1. **Explain** how parasitic and free-living flatworms are similar.
2. **Describe** the differences between parasitic and free-living worms.

▶ Conclude and Apply

1. **Identify** which body systems are more developed in free-living flatworms.
2. **Identify** which body system is more complex in parasitic flatworms.
3. **Infer** which adaptations allow some flatworms to live as free-living organisms.

Communicating Your Data

Compare and discuss your experiment design and conclusions with other students. For more help, refer to the **Science Skill Handbook**.



A natural sponge

SPONGES

A common household item
contains a lot of history

Sponges and baths. They go together like a hammer and nails. But sponges weren't always used just to scrub people and countertops. Some Greek artists dipped sponges into paint to dab on their artwork and crafts. Greek and Roman soldiers padded their

helmets with soft sponges similar to modern padded bicycle helmets to soften enemies' blows. The Roman soldiers also used sponges like a canteen to soak up water from a nearby stream and squeeze it into their mouths. Sponges have appeared in artwork from prehistoric times and the Middle Ages, and are mentioned in Shakespeare's play Hamlet.

Natural sponges have been gathered over time from the Mediterranean, Caribbean Sea, and off the coast of Florida. Divers used to carry up the sponges from deep water, but today sponges are harvested in shallower water. Synthetic sponges, made of rubber or cellulose, are used more today than natural ones. Natural sponges absorb more water and last longer, but synthetic sponges are less expensive. Natural sponges may also cure diseases. Medical researchers hypothesize that an enzyme produced by sponges might help cure cancer. Who says natural sponges are washed up?



Brainstorm Work with your classmates to come up with as many sayings and phrases as you can using the word *sponge*. Use some of them in a story about sponges. Share your stories with the class.

Science  **online**For more information, visit
life.msscience.com/time

Reviewing Main Ideas

Section 1 Is it an animal?

1. Animals are many-celled organisms that must find and digest their food.
2. Herbivores eat plants, carnivores eat animals or animal flesh, omnivores eat plants and animals, and detritivores feed on decaying plants and animals.
3. Animals have many ways to escape from predators such as speed, mimicry, protective outer coverings, and camouflage.
4. Invertebrates are animals without backbones. Animals that have backbones are called vertebrates.
5. When body parts are arranged the same way on both sides of the body, it is called bilateral symmetry. If body parts are arranged in a circle around a central point, it is known as radial symmetry. Animals without a specific central point are asymmetrical.

Section 2 Sponges and Cnidarians

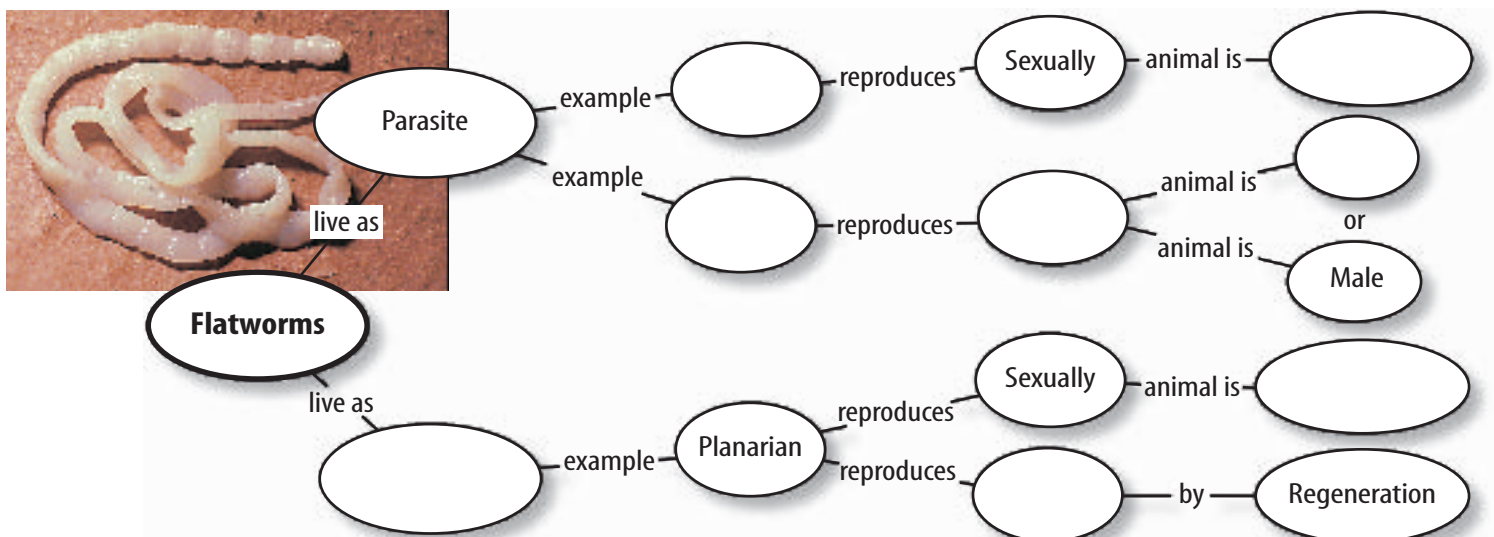
1. Adult sponges are sessile and obtain food by filtering water through their pores. Sponges can reproduce sexually and asexually.
2. Cnidarians are hollow-bodied animals with radial symmetry. Most have tentacles with stinging cells to obtain food.
3. Coral reefs have been deposited by reef-building corals over millions of years.

Section 3 Flatworms and Roundworms

1. Flatworms have bilateral symmetry. Free-living and parasitic forms exist.
2. Roundworms have a tube-within-a-tube body plan and bilateral symmetry.
3. Flatworm and roundworm species can cause disease in humans.

Visualizing Main Ideas

Copy and complete the following concept map.



Using Vocabulary

anus p. 347	medusa p. 339
bilateral symmetry p. 335	omnivore p. 331
carnivore p. 331	polyp p. 339
free-living organism p. 344	radial symmetry p. 335
herbivore p. 331	sessile p. 337
hermaphrodite p. 338	stinging cell p. 340
invertebrate p. 334	tentacle p. 340
	vertebrate p. 334

Find the correct vocabulary word(s).

1. animal without backbones
2. body parts arranged around a central point
3. animal that eat only other animals
4. animal that eat just plants
5. animal that produce sperm and eggs in one body
6. animal with backbones
7. body parts arranged similarly on both sides of the body
8. cnidarian body that is vase shaped
9. attached to one place
10. cnidarian body that is bell shaped

Checking Concepts

Choose the word or phrase that best answers the question.

11. Which of the following animals is sessile?
 - A) jellyfish
 - B) roundworm
 - C) planarian
 - D) sponge
12. What characteristic do all animals have?
 - A) digest their food
 - B) radial symmetry
 - C) free-living
 - D) polyp and medusa forms

13. Which term best describes a hydra?
 - A) carnivore
 - B) filter feeder
 - C) herbivore
 - D) parasite
14. Which animal has a mouth and an anus?
 - A) roundworm
 - B) jellyfish
 - C) planarian
 - D) tapeworm
15. What characteristic do scientists use to classify sponges?
 - A) material that makes up their skeletons
 - B) method of obtaining food
 - C) reproduction
 - D) symmetry
16. Which animal is a cnidarian?
 - A) fluke
 - B) heartworm
 - C) jellyfish
 - D) sponge

Use the photo below to answer question 17.



17. The photo above shows which hermaphroditic invertebrate organism?
 - A) fluke
 - B) coral
 - C) tapeworm
 - D) roundworm
18. How do sponges reproduce asexually?
 - A) budding
 - B) polyps
 - C) medusae
 - D) eggs and sperm
19. What is the young organism that the fertilized egg of a sponge develops into?
 - A) bud
 - B) larva
 - C) medusa
 - D) polyp
20. Which group do roundworms belong to?
 - A) cnidarians
 - B) nematodes
 - C) planarians
 - D) sponges

Thinking Critically

21. **Compare and contrast** the body organization of a sponge to that of a flatworm.
22. **Infer** the advantages of being able to reproduce sexually and asexually for animals like sponges, cnidarians, and flatworms.
23. **List** the types of food that sponges, hydras, and planarians eat. Explain why each organism eats a different size of particle.
24. **Compare and contrast** the medusa and polyp body forms of cnidarians.
25. **Infer** why scientists think the medusa stage was the first stage of the cnidarians.
26. **Form a hypothesis** about why cooking pork at high temperatures prevents harmful roundworms from developing, if they are present in the uncooked meat.
27. **Predict** what you can about the life of an organism that has no mouth or digestive system but has suckers and hooks on its head.
28. **Interpret Scientific Illustrations** Look at the photograph below. This animal escapes from predators by mimicry. Where in nature might you find the animal in this photo?



Performance Activities

29. **Report** Research tapeworms and other parasitic worms that live in humans. Find out how they are able to live in the intestines without being digested by the human host. Report your findings to the class.

30. **Video Presentation** Create a video presentation using computer software or slides to illustrate the variety of sponges and cnidarians found on a coral reef.

Applying Math

31. **Reef Ecology** Coral reefs are considered the "rain forests of the ocean" due to the number of different species that depend on them. If scientists estimate that out of 4,000 species, 1,000 are from the coral reef ecosystem, what percentage of life is dependent on the reef?

Use the table below to answer questions 32 and 33.

Reef Area Data

Country/Geographical Location	Reef Area [km ²]
Indonesia	51,000
Australia	49,000
Philippines	25,100
France	14,300
Papua, New Guinea	13,800
Fiji	10,000
Maldives	8,900
Saudi Arabia	6,700
Marshall Islands	6,100
India	5,800
United States	3,800
Other	89,800

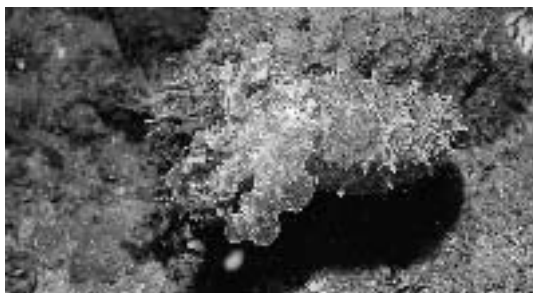
32. **Reef Disappearance** Coral reefs are disappearing for many reasons, such as increased temperatures, physical damage, and pollution. In 2003, scientists predict that at the current rate of disappearance, in 2100 coral reefs will be gone. Use the table above to calculate the current rate of coral reef disappearance.
33. **Reef Locations** What percentage of coral reefs are off of the Australian coast?

Part 1 Multiple Choice

Record your answers on the answer sheet provided by your teacher or on a sheet of paper.

1. An animal that kills and then only eats other animals is an
 A) omnivore. C) carnivore.
 B) herbivore. D) scavenger.
2. An animal that does not have a backbone is called
 A) a vertebrate. C) a hermaphrodite.
 B) an invertebrate. D) a medusa.

Use the illustration below to answer questions 3 and 4.



3. This animal escapes from predators by using
 A) behavioral adaptation.
 B) predator adaptation.
 C) mimicry.
 D) physical adaptation.
4. Markings that help an animal hide from its predators are called
 A) camouflage. C) behaviour.
 B) sessile. D) mimicry.
5. Which of the following is not a cnidarian?
 A) coral C) sea anemone
 B) hydra D) sponge

Test-Taking Tip

Study Advice Do not "cram" the night before a test. It can hamper your memory and make you tired.

6. Animals that have body parts arranged around a center point
 A) exhibit radial symmetry.
 B) exhibit bilateral symmetry.
 C) exhibit asymmetry.
 D) exhibit no symmetry.

Use the photo below to answer questions 7 and 8.



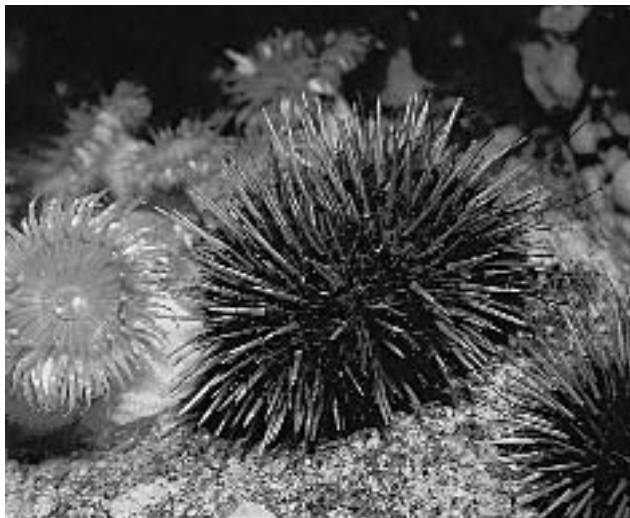
7. This organism would typically be found in which environment?
 A) lake C) ocean
 B) river D) pond
8. It would likely spend most of its life
 A) floating on water currents.
 B) attached to rock or coral.
 C) grouped in a colony.
 D) dependent on three other cnidarians.
9. Worms have which type of symmetry?
 A) asymmetry
 B) bilateral symmetry
 C) radial symmetry
 D) no symmetry
10. Which animal's body has the least complex body organization?
 A) cnidarians C) worms
 B) nematodes D) sponges

Part 2 Short Response/Grid In

Record your answers on the answer sheet provided by your teacher or on a sheet of paper.

- 11.** Name three adaptations, and give an example for each.

Use the photo below to answer questions 12 and 13.



- 12.** What types of classification and symmetry does this animal have and why?
- 13.** Compare and contrast this with the type of classification and symmetry you have as a human.
- 14.** How do sponges get food and oxygen?
- 15.** Explain how sponges reproduce. Do they have more than one method of reproduction?
- 16.** Explain the two forms of cnidarians.
- 17.** Describe structure of the stinging cells unique to cnidarians. What are the purposes of these cells?
- 18.** Explain the primary difference between a roundworm and a flatworm.
- 19.** Roundworms and flatworms are the simplest organism to have what feature?

Part 3 Open Ended

Record your answers on a sheet of paper.

- 20.** What are the characteristics that animals have in common and causes them to be included in their own kingdom?
- 21.** Animals need energy. They get this from food. Explain the differences between herbivores, carnivores, omnivores and detritivores. Be sure to include examples of all categories.
- 22.** Compare and contrast mimicry and camouflage. Give an example of both mimicry and camouflage.

Use the photo below to answer question 23.



- 23.** How is this animal useful to humans?
- 24.** Why is coral so important to us?
- 25.** Explain how two types of animals may interact in a host and parasitic relationship. Include humans in this discussion.
- 26.** Compare and contrast flatworms and roundworms. In your opinion, which are more developed? Defend your answer by providing examples.